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THE IMPACT AND PROMISE OF THE COGNITIVE REVOLUTION

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Abstract

Opening a new era in science, psychology's "cognitive revolution" overturns the long-time scientific rejection of mind and consciousness. Mental states, as emergent interactive properties of brain activity, become ineliminable for a complete explanation of conscious behavior and its evolution. Dualistic unembodied consciousness is excluded. A revised bidirectional mode of causal determinism combines traditional "bottom-up" microdeterminism with emergent "top-down" control. The methodology and practice of science are little changed, but the scientific view of ourselves and the world is radically transformed. Subsequent adoption of the bidirectional epistemology in other disciplines suggests it is replacing traditional reductive physicalism with wide humanistic and ideological, as well as scientific implications. Human values become the key to world change, the answer to our current global ills and high quality survival.

THE IMPACT AND PROMISE OF THE COGNITIVE REVOLUTION

It is a special pleasure and honor to participate in celebrating A.P.A.'s first one hundred years. With an eye toward the next hundred years, what I have to say is colored in no small part by a concern long shared with the late B.F. Skinner, namely, ***"Can A.P.A., or any other organization, count on another hundred years?"*** Skinner's answer became increasingly less optimistic, especially over the last decade, concluding, ***"The more we learn about human behavior, the less and less promising appear the prospects."*** My own answer, reflecting a similar vein of increasing concern, sees a possible ***ray*** of hope in psychology's cognitive revolution and what it could mean in bringing new perspectives, beliefs, and values -- in short, new mind-sets and a new way of thinking -- much needed if humanity is to survive the next century.

During A.P.A.'s first hundred years, psychology is said to have gone through no less than three major revolutions. In addition to the recent shift to cognitivism, there were the two earlier revolts associated with J. B. Watson and Sigmund Freud. I will try to show that, of the three, the current so-called cognitive, mentalist, or "consciousness" revolution is far and away the most radical turnaround: the most revisionary and transformative.

A main theme to emerge goes in brief as follows: In the cognitive revolution, psychology is leading the way among the sciences to a new and improved, that is, more comprehensive and valid conceptual foundation for scientific (and for all) causal explanation and understanding. Any perceived irony here is indeed quite real. Psychology, after having been put down for decades by the so-called "hard" sciences as not being really a science, is now turning the

tables: in effect, taking the position that traditional reductive physicalism is no longer tenable, and upholding instead a new paradigm for causal explanation that includes a place for mind and consciousness as legitimate and ineliminable causal constructs.

Along with other disciplines, even physics is beginning to adopt the new model of causation, at least in certain areas such as computer science, complexity theory, and non-linear dynamics (Gell-Mann, 1988; Gleick, 1987), but explaining, of course, that the new anti-reductive insights were discovered via approaches within physics. Similarly, in other disciplines many groups have now joined in and are discovering and adopting the new mode of causal explanation, each, however, having its own special version of how the innovations originated within its own particular field (e.g., Blakemore and Greenfield, 1987; Campbell, 1974; Popper & Eccles, 1977; Checkland, 1981; Goodwin, 1978; Greenberg and Tobach, 1990; Grene, 1987; D.R. Griffin, 1981; D. Griffin, 1988; Laszlo, 1972; Wasow, 1989). I strongly believe that, in the long run, history will show that psychology was actually where the new outlook was first established. Mainstream psychology had already adopted the new paradigm by the early 1970s (Dember, 1974; Matson, 1971; Palermo, 1971; Pylyshyn, 1973; Segal and Lachman, 1972), whereas the other fields have come to it later, especially in the '80s, and in effect, have just followed and developed varied forms and applications of what is in essence the same basic new core concept.

Advance Overview

I will start by quickly running over some of the salient features of the cognitive revolution as I see it: what it is, what it means, and what some of its consequences have been thus far. Firstly and primarily, the cognitive revolution constitutes a diametric turnaround in the treatment of mind and consciousness in science. The subjective contents of conscious experience, formerly eliminated from scientific

explanation on the grounds of being acausal epiphenomena or just identical to brain activity, now become functionally interactive and ineliminable for a complete explanation of conscious behavior. Our long-accepted microdeterminist tradition in neuroscience that brain function is fully accountable in neurocellular and physico-chemical terms is specifically contradicted, as is the general assumption that the materialist paradigm gives, in principle, a coherent and complete explanation of the natural world. In a sense, the cognitive/consciousness revolution represents a revolt against the long-time worship of the atomistic in science. It rejects the reductive microdeterministic view of ourselves and the world in favor of a more wholistic and "top-down", bidirectional approach. The higher, more evolved forces throughout nature, including the mental, vital, social and other high-order forces, are given their due as well as physics and chemistry.

It is important to stress that the changeover from behaviorism to mentalism does not go all the way from one previous extreme to the other, that is, to dualism. The shift, rather, is to a quite new intermediate position that integrates and blends aspects of prior opposed solutions into a novel unifying synthesis (Natsoulas, 1987). The new synthesis is mentalistic in holding that behavior is mentally driven, but is definitely ***not dualistic***. Mental states, as dynamic emergent properties of brain activity, become inseparably interfused with the functioning brain. Thus, consciousness cannot exist apart from the brain.

The bidirectional concept of causality applies not only to the mental, but also to emergent properties throughout nature, and accordingly is gaining wide acceptance also in other disciplines. What started out as an intra-disciplinary revolution within psychology appears now to be gradually turning into a major revolution for all science. In consequence scientific descriptions, not only of

behavior, the self, and personhood, but of all reality are being vastly transformed -- with wide humanistic as well as scientific implications. Like the Darwinian and Copernican revolutions, to which some authors now compare it, the cognitive revolution leads to a combined ***ideological*** revolution as defined by Karl Popper (1975). Different beliefs emerge about the ultimate nature of things. A new cosmology brings a new set of answers to some of humanity's deepest questions.

To many psychologists, such claims for the cognitive revolution will seem a lavish over-statement, even fanciful. I believe, however, that firm substantial backing can be found for each one of these assessments -- plus many more, yet-unmentioned extensions. Toward a preliminary understanding of why the impacts should be so profound and far-reaching, consider just the one fact: that the cognitive revolution, as here conceived, involves radical changes in, not just one, but in two key core concepts: namely, consciousness and causality. Both have extremely wide, almost ubiquitous application to everything we experience and try to understand. In view of this alone, it is obvious that the scientific shift to mentalism is bound to have numerous major and far-reaching consequences -- the list of which goes on and on.

Among further effects, the turnabout on the causality of consciousness abolishes the traditional science-values dichotomy. That we are in a new era in respect to values as compared to the 1950s and early '60s, is now well recognized (Edel, 1980). Some ethicists think the cognitive revolution might equally well have been called a "***values***" revolution. The old value-free, objective, quantitative views are replaced in science by a new recognition of rich and nonreductive macro qualities in both human and nonhuman nature. Human values, further, are no longer written off as ineffectual epiphenomena or as reducible to micro phenomena. In the new model human value

priorities become the most critically powerful force now shaping events in the civilized world (Sperry, 1972) -- the underlying answer to our current global ills and the key to world change.

By shifting mental states into a functional causal role, we open also a new approach to that age-old issue, the freewill-determinism paradox. The new outlook (blending previous opposites into a new middle-way position) allows a solution that combines retention of both freewill and determinism. The two are merged in a modified form, and moral responsibility is preserved (Sperry, 1964, 1973). What one ***wills*** to do is still determined, but it is ***subjectively self***-determined (just as it introspectively seems to be) by what one subjectively wishes or intends to do. Many degrees of freedom of choice are provided above the old reductive physicochemical determinacy. The result is of special importance for the scientific approach to personal agency and social theory (Bandura, 1989; Smith, 1983). We still inhabit a deterministic universe, but with many levels and types of determinism.

In sum, the kind of truth and worldview that science stands for, including the scientific perception of the forces that made and move the universe and brought the evolution of humankind, are vastly changed. Science gets a whole "new story", a new world outlook and a new image, and upholds a fundamentally revised picture of ourselves and the kind of world we live in. The previous gulf of mutual incompatibility that formerly separated the rich world of the humanities from the stark world of science (Jones, 1965; Snow, 1959), is bridged in a congenial new understanding.

Most importantly, perhaps, for those growing numbers among us who, like Skinner, see real concern about prospects for another hundred years, the conceptual developments instilled by the cognitive revolution lead to what is coming to be seen as the key to long-term high quality survival, namely, more realistic and sustainable ultimate

values and beliefs to live and govern by. For the first time it becomes possible to derive ethical and moral guidelines from a worldview and value-belief system that are consistent with science (Sperry, 1972, 1980, 1987, 1991a). Intrinsic ethico-moral directives furnish an ultimate moral basis for environmentalism, population balances, and other measures that would help to preserve and enhance for future generations the long-term evolving quality of the biosphere.

Perspectives That Need to be Clear

Before going further, we need to clarify some frequent sources of misconception. Firstly, at a time when it seems to be open season on personal theories of consciousness, we are dealing here not merely with personal, obscure, or even minority opinion, but with the mainstream doctrine and actual working conceptual framework over the past two decades of a whole discipline of science (Baars, 1986; Gardner, 1985; Sperry, 1987). The focus is not so much on abstract philosophy or theory as on scientific history, and the majority position of the science that specializes in mind and behavior and thus best speaks for science as a whole in these matters.

Secondly, when I speak of behaviorism here, I mean ***Behaviorism per se***, in the sense of an overriding paradigm, metatheory, or working conceptual framework for psychology in general. The reference is not to any of the various subordinate theories, practices and approaches to behavior and brain function that incidentally may have become associated with behaviorism because they happened to come into vogue during its half-century reign. It is the overriding conceptual paradigm itself that the cognitive revolution has overthrown, including especially behaviorism's renunciation (in common with the other natural sciences) of the validity of mental or any subjective constructs in causal explanation.

Thirdly, our concern throughout is not with any questionable, esoteric or radical fringe developments in science, but rather with the basic working premises of solid fundamental mainstream science. The principles and history of science in general are a central question. Remaining adamant "behaviorists" are taken to represent a respected minority challenging the basic principles at issue, but no longer representative of mainstream psychology.

Finally, it is worth repeating, in view of salient misconceptions (e.g., Bunge, 1980), that the new mentalism upheld here is not dualistic in the classic philosophic sense of different independent realms of existence. The new macro-mental paradigm is mentalistic in the assertion that mental states cause behavior (in contradiction to the tenets of behaviorism). In the new synthesis, mental states, as dynamic emergent properties of brain states, are no longer dualistic because they are extricably interfused with their generating brain states, and cannot exist apart from the active brain. Mental-level explanation acquires a new scientific legitimacy. At the same time mental states are not the same as brain states as the latter ordinarily are perceived. The two are distinct and different in the way that any dynamic emergent property is different from its component infrastructure. It is characteristic of emergent properties that they are notably novel and often amazingly, even unexplainably different from the components of which they are built.

Contested Historical Aspects

It is some 20 years since the cognitive revolution became an established turning point in scientific history. Yet there still exists no generally accepted consensus as to what exactly it is, how it came about, or what it means. Within psychology itself different schools and special interest groups continue to vie over these and related questions (e.g., Amsel, 1989; Baars, 1986; Bevan, 1991;

Bolles, 1990; Chezik, 1990; Keil, 1991; Kendler, 1990; Lamal, 1990; Natsoulas, 1987; Simon, 1990; Wasow, 1989). If the impact and potential of the cognitive revolution are anything like what is inferred here, it becomes of crucial importance that we try to better understand the nature, origins, and exactly what is implied by what has variously been called the cognitive, consciousness, mentalist, humanist, or third revolution.

In the view presented here the story of the cognitive revolution is not one of finding new positives to support the role of cognition, plenty of which were already evident. The story, rather, is one of discovering a new logical alternative to the seemingly airtight and incontestable arguments and principles by which science heretofore had succeeded in effectively ostracising mind and consciousness. How this discovery came about is most easily explained in terms of the historical context out of which the new answers arose.

Well into the 1960s the riddle of the mind-brain relation still posed a contradictory paradox: On the one hand, it seemed directly obvious from common experience that behavior is ***mentally*** driven. Conversely, it seemed equally obvious from the standpoint of neuroscience that a complete account of brain function would be possible eventually in strictly objective neurocellular and physico-chemical terms. Absolutely no place could be seen in the causal explanations of neuroscience for the likes of conscious or mental forces. In psychology, behavorism as "a philosophy of science" (Skinner, 1964), that made psychology consistent with the objective materialist traditions of the neuro and other natural sciences, appeared to be irrefutable all through its heyday decades. To overthrow behaviorism would logically require an overthrow also of the conceptual foundations of science in general with which it was consistent. As humanist Andrew Bongiorno (1991), now in his nineties, recalls, "For half a century behaviorism reigned supreme in academe".

What then led to its downfall? Or, put another way, What made cognitivism suddenly rise in its own right, no longer under the restrictive dictates of a reigning behaviorism as in the days of Edward Tolman, but rather as a new and independent positive paradigm predicating a worldview and tenets of its own that stood opposed to the long-dominant behaviorist/materialist paradigm? Whatever caused this turnabout, it came with a surprising suddenness, described by Pylyshyn (1973, p. 1) as having "***recently exploded***" into fashion.

Mindsets of 1964

As late as 1964 there still was no incipient sense of the impending turnabout as evidenced in various conferences, books and articles of the period (e.g., Bertalanffy, 1968; Feigenbaum and Feldman, 1963; Feigl, 1967; Eccles, 1966; Hook, 1960; Smythies, 1965; Wann, 1964). Within psychology the continuing debates between phenomenologists and behaviorists were still going on as before, without shaking the dominant reign of the behaviorist position (Wann, 1964). In 1964 humanist Carl Rogers, who had searched over a long career for a scientific foundation for what he called "subjective knowing," was still summarizing the situation as "an irreconcilable contradiction" and "deep paradox" with which we just have to learn to live (Rogers, 1964). In September of the same year the eminent neurophysiologist John Eccles reaffirmed at the Vatican Conference on Consciousness his reasoned conviction as a scientist, in line with neurophysiology as a whole, that consciousness is totally superfluous from the standpoint of neuroscience. But then, expressing what many of us felt subjectively, he added "I do not believe this story, of course, but I do not know the logical answer" (Eccles, 1966, p. 248). The finding of this logical answer was not far away and would be the key factor in making possible the cognitive revolution.

By 1971 it already was clear that many psychologists had come to recognize that their discipline was in the process of a major paradigm revolt in which behaviorism was being replaced by an opposing new mentalism or cognitivism (Matson, 1971; Palermo, 1971; Segal and Lachman, 1972). Thus, the revisionary concepts of the new mentalist paradigm -- those concepts that finally broke the materialist logic in which science had been locked for over 200 years -- must by then, not only have been introduced, but have become sufficiently clear and familiar to cause mainstream psychology to start swinging its support to the new mentalism. During the short interim, therefore, between 1964 and 1971, something must have happened to reveal the long-sought answer to the baffling logical impasse.

Key Factor

What happened, I believe, was the discovery that the supposedly closed, complete and incontestable logic by which consciousness had traditionally been excluded from scientific explanation was in fact basically flawed or incomplete and that this could be rectified through an improved conception of causation. An alternative (bidirectional) model was perceived that gave conscious experience a functionally interactive, causal role (Popper, 1965; Sperry, 1964, 1965), thus breaking the long-standing impasse and "irreconcilable contradiction" of the mind-brain paradox.

The answer to why this particular alternative succeeded where innumerable others had failed lies in the use of a quite different approach. Previous efforts had stayed within the traditional reference frame, attempting to insert consciousness within the chains of causation already covered in neuroscience, for example, at synaptic junctions between brain cells (Eccles, 1953). By contrast, the successful effort preserved intact the micro chains of causation already dealt with in neuroscience, and simply encompassed or embedded

these within a higher-level (yet-to-be-described) cognitive system of cerebral processing in which conscious qualities as subjectively experienced are included as irreducible emergent dynamics of brain processing. In other words, success was attained only by changing the rules of the game, that is, by inventing a revised paradigm for scientific causal explanation.

In regard to the question of which of the two models of causality might be taken to be more valid, mainstream psychology, in a move involving hundreds or thousands of critical specialist minds, viewing the issue from all kinds of different sub-disciplinary angles, chose collectively to switch from the tenets of behaviorism to those of the new mentalism. Many reasons supporting this choice can now be seen which, without going into detail, add up to the fact that nothing is lost (since microdeterminism *per se* is preserved) and much is gained. In briefest possible terms, the new "double-way" model combines traditional "bottom-up" microdeterminism with novel principles of emergent, "top-down" macro and mental causation (Dewan, 1976; Natsoulas, 1987; Popper & Eccles, 1977; Ripley, 1984; Rottschaefer, 1987; Sperry, 1964, 1991a, 1991b). A strengthened concept of the "irreducible whole" is involved in which the spacing and timing of infrastructural components is predicated to be causative in itself. Involving immense same-level as well as interlevel multinested space-time complexities, this rules out reduction -- even "in principle". An additional factor of relativity of reference frames and other details are reviewed elsewhere (Sperry, 1991b). Illustrated in simple physical examples such as the space-time trajectory of a molecule within a rolling wheel, a flowing eddy, a flying plane, wave action, and others, the existence of downward causation, as Popper observes (Popper and Eccles, 1977, p. 209), seems obvious.

Psychology in the Lead?

What applies to consciousness as an emergent property of brain processes, applies also to emergent or "macro" properties elsewhere in nature and this is fast becoming recognized in other disciplines. Following psychology's shift, started in the 1960s and established by the early 1970s, the new outlook began to spread to other disciplines. Never before in the history of science has there been such an outburst of "new sciences," new worldviews, "new visions of reality," "new epistemologies," and so on. The 1980s, especially, might be well called "the decade of emerging new paradigms." We soon had the "new systems view of the world" (Laszlo, 1972) and the new "Worlds 2 & 3" of Popper (1972), the "Tao of physics" (Capra, 1977), "the cognitive view of biology" and the new "science of qualities" (Goodwin, 1978), the "Aquarian Conspiracy" (Ferguson, 1980), the "new view of animal awareness" (Griffin, 1981), "new story of science" (Augros and Stanciu, 1984), "new dialogue with nature" (Prigogine and Stengers, 1984), the "new evolutionary epistemology" (Greenberg and Tobach, 1988), a "reenchantment of science" and a new "postmodern era" (Griffin, 1988; Toulmin, 1982) -- and the list goes on.

All these new developments have one thrust in common, namely, the rejection of traditional reductive physicalism -- heretofore a seemingly impregnable, complete and coherent paradigm that had proven itself preeminently over centuries. All these developments thus depend in final analysis on the presumed existence of some logical flaw, incompleteness, or inadequacy in traditional microdeterminism. We yet know of only one such flaw that would appear to qualify, namely that corrected through the principle of emergent determinism that changes the causal status of mind and consciousness. Microdeterminism itself is not rejected, only the assumption that it is complete and exclusive. The day-to-day practice and methodology of science are

little changed. A transformed world-picture and story of science are achieved without losing the previous benefits. Nothing is lost and a whole new outlook on existence is gained.

Science-Consistent Beliefs for a Sustainable World

The second part of my thesis, "the promise", calls for a change of mind-set. We go back to Skinner's concern about making it through another century. Most of the foregoing is dwarfed in significance compared to the issue of survival now becoming the great overriding imperative of our times, scientifically, academically, politically, economically, and every other way: a "cause of all causes" which, should it fail, all others go with it. What good is a new theory of consciousness, of memory, hemisphericity, personhood, society -- or ***anything*** that has seemed important -- if all is to be lost shortly in the oblivion of extinction? It has now become widely accepted that to avoid extinction will inevitably require some radical changes global in nature, in human behavior, mind-sets, life-styles, social priorities, and the like. What group is professionally better qualified and in a better position, than behavioral science, especially with its new outlook on existence, to provide sound ideas and proposals for the kind of new world order we need and want, and how to get there?

Tentative examples of the kinds of suggestions and supporting rationale that derive from the revised new outlook described above are presented below in the form of a general argument and prescription for a high quality sustainable world. This is something always debateable, but at least illustrates a possible starting target, something to aim at. The bottom-line message runs something as follows: ***Given the consciousness/cognitive revolution, we can look to science to save the world, not through new technology (which, with growing population pressures, just buys some time and thereby further***

magnifies the impending downfall) but by providing instead more realistic beliefs and values to live and govern by. This message is not new, but received rather short shrift from both scientists and ethicists when earlier voiced in 1970 (Sperry, 1972). The arguments, however, still hold and current ambient attitudes seem more receptive.

Science, Values, and the Human Predicament: Today's mounting global (social) ills will not be cured by applying more or better science and technology. Despite the marvels and apparent successes, the gains achieved are typically offset by the incessantly expanding demands of growing human numbers. In the context of rising population pressures, technological solutions just lead over time to further escalation of our collective problems. It is a paradox of today's global predicament that almost anything that makes humanity fare or thrive better in the short term -- a new energy source, an aquaduct, another mass transit, or whatever -- just serves in the long term to further escalate our collective problems and our eventual downfall, or possible extinction. Slowly but surely, our civilization gets ever more deeply enmeshed in a vicious spiral of mounting population, pollution, increased energy demands, environmental degradation, urban crowding and associated crime, homelessness, and hopelessness. With one thing reinforcing another, we become more and more firmly entrapped year by year.

What's needed to break the vicious spiral is a basic revision worldwide in human life styles, aims and attitudes, with redirection of social values and policy toward long-term priorities that will preserve an evolving quality of life for future generations. A major conversion is called for in our ultimate goals and values, or, as Einstein put it in reference to atomic power, "We need a new way of thinking if mankind is to survive."

Such a new way of thinking with promising qualifications is emerging in science today. Spawned by the cognitive/consciousness

revolution, it reaffirms the humanistic view that the world we live in is driven not solely by mindless physical forces but also, and much more crucially, by human values. Human values become the underlying key to the human predicament -- and its solution. The battle to save the planet becomes, in large measure, a battle over values.

The reason our traditional value systems aren't working today -- are driving us and our entire ecosystem toward collapse -- is because the starting assumptions are wrong for modern times. Human values are not designed as absolutes, immutably pre-fixed by natural law or divinely ordained. Human values by nature are evolutionary, interrelated and conditional on the situations in which they evolve (Pugh, 1977). To cling to unchanging values in a rapidly changing world can be fatal.

For centuries it has been the starting assumption that because human life is special, even sacred, the more the better. "Go forth and multiply and take dominion..." was morally good at the time the Scriptures were written. Two thousand years later, however, with the global situation reversed, with an exploding world population and its multiform side effects threatening to destroy everything we value, it follows today that because human life is precious, even sacred, *less is better*. "Retract and multiply less" becomes today's prime commandment. To proceed otherwise is to risk losing it all. This inescapable reversal in starting assumptions goes against long-revered imperatives demanding that we now turn around a large complex of centuries-old cultural traditions and values in order to preserve the sanctity of life.

To turn the rising tide of today's adverse global trends will require an inevitable new ordering in social priorities sustained by convictions equal to, or more powerful than those of the past. A new, higher outlook is called for, an outlook that can override

deep-rooted value systems of nations, religions, and different cultures --including even long-esteemed traits inherent in human nature, but evolved without regard for the projected effects in today's kind of world. Many immediate humanitarian reactions will need to be curbed by more far-sighted vision of what is most humane.

Considering the massive carry-over and long-term momentum in world population growth and in correlated adverse trends -- and assuming that social system breakdowns and a point of no return are bound to occur well in advance of the final crunch -- there may be less time than we think. Twenty years ago we could still see a choice: either adopt new values by foresight, or have them forced by a mounting intolerability in living conditions. Today, almost everywhere we turn the signs of overload and margins of intolerability already are showing. Rising demands for subsistence in a direly depleted, degraded ecosphere are not the sole concern. In numerous subtle and unsubtle ways excessive overpopulation tends to desensitize humanity and make the individual person increasingly expendable. Our sense of the specialness of human life, its meaning, singular worth and wonder undergoes an insidious, unobtrusive but inexorable erosion to which our inherent human nature is particularly vulnerable. The process is so slow and the habituation capacity of the human brain so great that the many adverse trends, spread over decades or even generations, tend to go unnoticed and become adjusted to without question.

Instead of evading population issues, we urgently need the opposite: intensive study and open debate toward informed views of what optimal population levels might be, regionally and globally, and ideals to strive for in an overall guiding plan for existence on planet Earth. Desperately needed are some new Utopian goals we can at least aim for, instead of just drifting further with outdated guidelines of a distant past.

It is important to remember here that the more rarity, diversity, and contrast in our life and world, the greater the value and meaning. A world overrun, dominated by, and designed to maximize, equalize, and homogenize the human "carrying capacity" automatically degrades and demeans human life. We each tend to adjust to our own personal "baseline of happiness," below which things are depressing and above which rosy. These baselines do not need to be all equalized: The proven benefits of biodiversity do not stop at the human social order.

The sheer immensity of the global rescue effort we now face, combined with the requisite restructuring in the social and moral order, the changeover worldwide to a new outlook that transcends present national, cultural and religious traditions, plus global legislation that secures the rights of distant future generations, when taken together, present a collective formidable hurdle that seems almost insurmountable. When we then add the extreme urgency in action required in order to ensure for coming generations a viable, quality ecosphere, the task would appear to demand nothing short of an immediate ideological conversion of humankind worldwide. The hard choices ahead pitting increasing human needs against those of disappearing wilderness, endangered species, or agreeing to not have additional much-desired children, and so on, call for a reformed perception of ultimate value and the highest good, backed by almost religious passion and commitment.

Aside from the urgency factor, some of us see possible hope in the new outlook and way of thinking in science with its upgraded concepts of the cosmic forces that made and move ourselves and the world (Sperry, 1991a). Humanity's creator becomes the vast interwoven fabric of all evolving nature. The highest good becomes an ever-evolving quality of existence, and an open continuing future a *sine qua non* for higher meaning. Evolution becomes a gradual

emergence of increased directedness, purpose, and meaning among the forces that move and govern living things. The creative forces and creation itself become inextricably interfused.

Such perspectives, as a common core for human belief, and based in the neutral universality and credibility of science, might prove an acceptable foundation for a higher system of world law and justice -- and at the same time help also to arouse a deep sense of outrage at what modern humanity is doing to itself and its future.

Where the quality of life of coming generations is given its due, the regard for human life as sacred, with rights to be protected is fully retained. But it is lifted above the realm of this generation and immediate humanitarian reactions into a much greater, more long-term framework. The very definition of human rights needs to encompass the rights and welfare of coming generations. Current world conditions will make it the overriding moral imperative in coming decades, critical to the "battle to save the planet".

A world community more and more overburdened with personal survival cannot be expected to voluntarily act in the interests of a biosphere of the distant future. Planet-wide pressures of some kind seem indicated -- perhaps systems of compensatory incentives, reinforced by changes in societal structure, for example, toward a greater sharing of children.

With hardly the time to educate and convince the voting majority of an increasingly democratized world, society's best hope for an outcome that is noncatastrophic and humane would seem to lie in a reformed and enhanced United Nations, World Federation, or World Security System *of some sort* administering a new higher system of world law and justice.

The promise of the cognitive revolution is multiform, but in the context of today's global ills and our imperilled future, it may be seen to rest especially in its bringing to science a higher level of meaning -- one which employs the emergent properties of specialized

brain processes to inject new beliefs and value systems into the twenty-first century and to catalyze their acceptance.

References

Amsel, A. (1989). Behaviorism, neobehaviorism, and cognitivism in learning theory: Historical and contemporary perspectives. Hillsdale, NJ: Erlbaum.

Augros, R. M., & G. N. Stanciu. (1984). The New Story of Science. New York: Bantam.

Baars, R. J. (1986). The cognitive revolution in psychology. New York: Guilford.

Bandura, A. (1989). Human agency in social cognitive theory. American Psychologist, 44, 1175-1184.

Bertalanffy, L. von. (1968). General systems theory. New York: Braziller.

Bevan, W. (1991). A tour inside the onion. American Psychologist, 46, 475-483.

Blakemore, C., & S. Greenfield. (1987). Mindwaves: Thoughts on intelligence, identity and consciousness. Oxford: Basil Blackwell.

Bohm, D. J. (1980). Wholeness and the implicate order. London: Routledge & Kegan.

Bolles, R. C. (1990). Where did everybody go? Psychological Science, 1, 112-13.

Bongiorno, A. (1991). Personal communication.

Bunge, M. (1980). The mind-body problem. New York: Pergamon Press.

Campbell, D. T. (1974). Downward causation in hierarchically organized biological systems. In F. J. Ayala & T. Dobzhansky (Eds.), Studies in the philosophy of biology (pp.139-161). Berkeley: University of California Press.

Capra, F. (1977). The tao of physics. East Lansing, MI: Shambhala.

Checkland, P. (1981). Systems thinking, systems practice. New York: John Wiley & Sons.

Chezik, D. D. (1990). Sperry's emergent interactionism. American Psychologist, 45: 70.

Dember, W. N. (1974). Motivation and the cognitive revolution. American Psychologist, 29, 161-168.

Dewan, W. N. (1976). Consciousness as an emergent causal agent in the context of control system theory. In G. G. Globus, G. Maxwell, & I. Savodnik (Eds.), Consciousness and the brain (pp.179-198). New York: Plenum Press.

Eccles, J. C. (1953). The neurophysiological basis of mind: The principles of neurophysiology. Oxford: Clarendon Press.

Eccles, J.C. (Ed.) (1966). Brain and conscious experience. New York: Springer.

Edel, A. (1980). Exploring fact and value (Vol 2). New Brunswick, NJ: Transaction Books.

Feigenbaum, E. A., & Feldman, J. (Eds.) (1963). Computers and thought. New York: McGraw-Hill.

Feigl, H. (1967). The "mental" and the "physical". (With "postscript after ten years.") Minneapolis: University of Minnesota Press.

Ferguson, E. S. (1980). The aquarian conspiracy. Los Angeles: Tarcher.

Gardner, H. 1985. The mind's new science: A history of the cognitive revolution. New York: Basic Books.

Gell-Mann, M. (1988). Simplicity and complexity in the description of nature. Engineering and Science, 51(3), 2-9.

Gleick, J. (1987). Chaos: making a new science. New York: Viking Press.

Goodwin, B. C. (1978). A cognitive view of biological process. Journal of Social and Biological Structures, 1, 117-125.

Greenberg, G., & Tobach, E. (1988). Evolution of social behavior and integrative levels. The T. C. Schneirla Conference Series (Vol. 3). Hillsdale, NJ: Lawrence Erlbaum.

Grene, M. (1987). Hierarchies in biology. American Scientist, 75, 504-510.

Griffin, D. R. (1981). The question of animal awareness. New York: Rockefeller University Press.

Griffin, D. (1988). The reenchantment of science. New York: SUNY.

Hook, S. (Ed.). (1960). Dimensions of mind. New York: Collier Books.

Jones, W. T. (1965). The sciences and the humanities. Berkeley: University of California Press.

Keil, F. C. (1991). On being more than the sum of the parts: The conceptual coherence of cognitive science. Psychological Science, 2, 283, 287-293.

Kendler, H. H. (1990). Looking backward to see ahead. Psychological Science, 1, 107-112.

Lamal, P. A. (1990). The continuing mischaracterization of radical behaviorism. American Psychologist, 45, 71.

Laszlo. E. (1972). The systems view of the world; The natural philosophy of the new developments in the sciences. New York: Braziller.

Matson, F. W. (1971). Humanistic theory: The third revolution in psychology. The Humanist 31(2), 7-11.

Natsoulas, T. (1987). Roger Sperry's monist interactionism. The Journal of Mind & Behavior, 8, 1-21.

Palermo, D. S. (1971). Is a scientific revolution taking place in psychology? Science Studies, 1, 135-155.

Popper, K. R. (1965). See Popper, 1972.

Popper, K. R. (1972). Of clouds and clocks. In K. Popper (Ed.), Objective knowledge (pp.206-255). Oxford: Clarendon Press. (Second Arthur Holly Compton Memorial Lecture, presented April 1965).

Popper, K. R. (1975). The rationality of scientific revolutions. In R. Harre (Ed.), Problems of scientific revolution (pp.72-101). Oxford: Clarendon Press.

Popper, K. R., & Eccles, J.C. (1977). The self and its brain. New York: Springer International.

Prigogine, I., & Stengers, I. (1984). Order out of chaos: Man's new dialogue with nature. New York: Bantam.

Pugh, G. E. (1977). The biological origin of human values. New York: Basic Books.

Pylyshyn, Z. W. (1973). What the mind's eye tells the mind's brain: A critique of mental imagery. Psychological Bulletin, 80, 1-24.

Ripley, C. (1984). Sperry's concept of consciousness. Inquiry, 27, 399-423.

Rogers, C. R. (1964). Freedom and commitment. The Humanist, 29(2), 37-40.

Rottschaefer, W. A. (1987). Roger Sperry's science of values. The Journal of Mind & Behavior, 8, 23-35.

Segal, E. M., & Lachman, R. (1972). Complex behavior or higher mental process? Is there a paradigm shift? American Psychologist, 27, 46-55.

Simon, H. A. (1991). What is an "explanation" of behavior? APS Observer, 2(1), 6.

Skinner, B. F. (1964). Behaviorism at 50. In T. Wann (Ed.), Behaviorism and phenomenology (pp.79-108). Chicago: University of Chicago Press.

Smith, M. Brewster. (1983). The shaping of American social psychology: A personal perspective from the periphery. Personality and Social Psychology Bulletin, 9, 165-180.

Smythies, J. R. (Ed.). (1965). Brain and mind: Modern concepts of the nature of mind. London: Routledge & Kegan Paul.

Snow, C. P. (1959). The two cultures and the scientific revolution. New York: Cambridge University Press.

Sperry, R. W. (1964). Problems outstanding in the evolution of brain function. James Arthur Lecture on the Evolution of the Human Brain. New York: American Museum of Natural History.

Sperry, R. W. (1965). Mind, brain and humanist values. In J.R. Platt (Ed.), New views of the nature of man (pp.71-22). Chicago: University of Chicago Press. (Abridged in Bulletin of the Atomic Scientists, 1966, 22(7), 2-6.)

Sperry, R. W. (1972). Science and the problem of values. Perspectives in Biology & Medicine, 16, 115-130.

Sperry, R. W. (1973). See Sperry, 1976.

Sperry, R. W. (1976). Changing concepts of consciousness and free will. Perspectives in Biology & Medicine, 20, 9-19. (Presented November, 1973in the Gerstein Lecture Series at York University, Toronto.)

Sperry, R. W. (1980). Mind-brain interaction: Mentalism, yes; dualism, no. Neuroscience, 5(2), 195-206.

Sperry, R. W. (1985). Nobel prize conversations. With J.Eccles, I.Prigogine & B.Josephson, with commentary by Norman Cousins. Dallas, TX: Saybrook.

Sperry, R. W. (1987). Structure and significance of the consciousness revolution. The Journal of Mind & Behavior, 8, 37-65.

Sperry, R. W. (1991a). Search for beliefs to live by consistent with science. Zygon, Journal of Religion & Science, 26, 237-258.

Sperry, R. W. (1991b). In defense of mentalism and emergent interaction. Journal of Mind & Behavior, 12, 221-245.

Toulmin, S. (1982). The return to cosmology. Berkeley: University of California Press.

Wann, T. W. (Ed.). (1964). Behaviorism and phenomenology: Contrasting bases for modern psychology. Chicago: University of Chicago Press.

Wasow, T. (1989). Grammatical theory. In M. I. Posner (Ed.), Foundations of cognitive science (pp.161-202). Cambridge: MIT Press.